AD-A034 612 AIR FORCE ACADEMY COLO F/G 13/2
POLITICAL OVERBOUNDEDNESS AND THE URBANIZATION OF RURAL SETTLEM--ETC(U)
NOV 76 A P TRIBBLE
UNCLASSIFIED USAFA-TR-76-22 NL

1 OF 1
AD-A
034 612

END
DATE
FILMED
3-5-77
NTIS

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

AD-A034 612

POLITICAL OVERBOUNDEDNESS AND THE URBANIZATION OF RURAL SETTLEMENT PATTERNS

Air Force Academy, Colorado

November 1976

USAFA-TR-76-22

POLITICAL OVERBOUNDEDNESS AND THE URBANIZATION OF RURAL SETTLEMENT PATTERNS

CAPTAIN A. PAUL TRIBBLE

DEPT OF ECONOMICS, GEOGRAPHY
AND MANAGEMENT
USAF ACADEMY, COLORADO 80840

NOVEMBER 1976
FINAL REPORT

DEAN OF THE FACULTY
UNITED STATES AIR FORCE ACADEMY
COLORADO 80840

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER USAFA-TR-76-22	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) POLITICAL OVERBOUNDEDNESS AND THE URBANIZATION OF RURAL SETTLEMENT PATTERNS		5. TYPE OF REPORT & PERIOD COVERED FINAL REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Captain A. Paul Tribble		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Economics, Geography, and Management United States Air Force Academy, Colorado 80840		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DFEGM USAF Academy, Colorado 80840		12. REPORT DATE November 1976 13. NUMBER OF PAGES 42
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Texas
Political overboundedness
Residential growth

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Metropolitan political overboundedness influences the direction and rate of urban residential growth in Texas. In overbounded and non-overbounded cities, development was similar in the zone immediately adjacent to the built-up area of the city. In the more distant areas, however, the density of dwellings per square mile was significantly greater in overbounded city samples, contributing to a difference between city types in the process of residential development.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Editorial Review by Lt Col Shuttleworth
Department of English and Fine Arts
USAF Academy, Colorado 80840

This research report is presented as a competent treatment of the subject, worthy of publication. The United States Air Force Academy vouches for the quality of the research, without necessarily endorsing the opinions and conclusions of the author.

This report has been cleared for open publication and/or public release by the appropriate Office of Information in accordance with AFR 190-17 and DODD 5230.9. There is no objection to unlimited distribution of this report to the public at large, or by DDC to the National Technical Information Service.

This research report has been reviewed and is approved for publication.

Philip J. Erdle

PHILIP J. ERDLE, Colonel, USAF
Vice Dean of the Faculty

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Since World War II the population of cities in the United States has been steadily shifting away from city centers and increasing at the peripheries.[1] Peripheral growth will constitute the dominant form of future urban population expansion, overshadowing growth attributable to new cities and satellite communities.[2]

Social scientists of various disciplines analyzed the horizontal growth of cities. Geographic and kindred literature describing urban spatial growth dealt with three areas; land values,[3] the developer decision-making process,[4] and socio-economic characteristics

---

[1]Ronald R. Boyce, "The Edge of the Metropolis: The Wave Theory Analog Approach," British Colombia Geographical Series, No. 7 (1966), pp. 31-40; Bruce F. Newling, "The Spatial Variation of Urban Population Densities," Geographical Review, Vol. 59 (1969), pp. 242-252.

[2]Anthony Downs, "Alternative Forms of Future Urban Growth in the U.S.," Journal of the American Institute of Planners, Vol. 36 (1970), pp. 3-11.

[3]William Alonso, "A Theory of the Urban Land Market," Papers and Proceedings of the Regional Science Association, Vol. 6 (1960), pp. 149-158; William Alonso, Location and Land Use, Toward a General Theory of Land Rent (Cambridge: Harvard University Press, 1964); Richard F. Muth, "Economic Change and Rural-Urban Land Use Conversions," Econometrica, Vol. 29 (1961), pp. 1-24.

[4]F. Stuart Chapin, Jr. and Shirley F. Weiss, Factors Influencing Land Development (Chapel Hill: University of North Carolina Press, 1962); F. Stuart Chapin, Jr., Thomas G. Donnelly, and Shirley F. Weiss, "A Model for Simulating Residential Development," Journal of the American Institute of Planners, Vol. 21 (1965), pp. 120-125; Thomas G. Donnelly, F. Stuart Chapin, Jr., and Shirley F. Weiss, A Probabilistic Model for Residential Growth (Chapel Hill: University of North Carolina Press, 1964).

of fringe residents.[5] In none of this literature has the purpose been to associate horizontal urban growth with the amenities offered by a city location. This new approach to the analysis of peripheral growth is the basis for this research report.

SPATIAL ASPECTS OF ANNEXATION

Two functional types of urban political boundary expansion exist. The first occurs where an urban government extends its borders to incorporate growth that has extended beyond established political limits. The second type occurs in cities where political limits expand to include rural land, insuring room for expansion and consequently influencing the direction of growth. This second type creates overbounded cities. The first annexation type is an *ex post facto* action, whereas the second provides a method of establishing rigorous control over growth using building codes and zoning.

In the South and West of the United States, urban governments have attempted to control sprawl by continually extending their boundaries through annexation. Cities in those areas are fewer and more scattered than in the older, more densely settled Northeast where

---

[5] J. Allan Beegle, "Characteristics of Michigan's Fringe Population," *Rural Sociology*, Vol. 12 (1947), pp. 254-263; Samuel W. Blizzard, "Research on the Rural-Urban Fringe," *Sociology and Social Research*, Vol. 38 (1954), pp. 143-149; R.J. Johnston, "The Population Characteristics of the Urban Fringe; A Review and Example," *Australian and New Zealand Journal of Sociology*, Vol. 2 (1966), pp. 70-93.

the political boundaries of cities are close and there is little room for expansion. No incorporated municipalities generally encircle Southern and Western cities, and consequently, political barriers to expansion are absent. Here, also, lenient annexation statutes have contributed to the common practice of annexing to extend political boundaries.[6]

I selected Texas as the state for the examination of residential growth because of its location in the Southwest. Since overboundedness exists in abundance in this area, if residential growth characteristics related to this phenomenon do not exist here, they probably do not exist. Texas additionally governs the annexations of several large cities by a homogeneous set of state urban annexation laws.

I obtained dwelling density data from mile square samples to determine the residential character of land immediately peripheral to the built-up areas of the eleven cities which had 1960 populations of 100,000 or more (Fig. 1). These eleven cities had populations large enough to sustain residential growth in several directions around the geographic city. The residential character of land and the cost curves adjacent to Texas cities may differ from those exhibited for cities elsewhere. My belief is, however, that cost

---

[6]David G. Bromley and Joel Smith, "The Historical Significance of Annexation as a Social Process," Land Economics, Vol. 49 (1973), pp. 294-309.

and density curves presented herein will possess the same general form as those for other American cities with similar amounts of overboundedness.

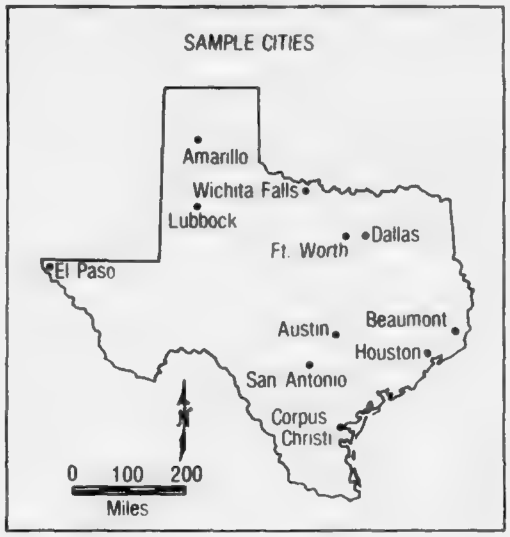

Figure 1. Location of Sampled Cities

HYPOTHESIZED RESIDENTIAL GROWTH

I contend that the extension of a city's political limits to encompass large tracts of rural land influences the form and process of residential development around the built-up city. Density of dwellings served as a surrogate variable for residential development ot test the hypothesis. I examined mean densities per square mile to determine differences in the form of residential development, and slopes of densities as indicators of the differing

process of development between overbounded and non-overbounded cities. Sample square miles for overbounded cities are within the city's political limits, but samples from non-overbounded cities are not (Fig. 2).

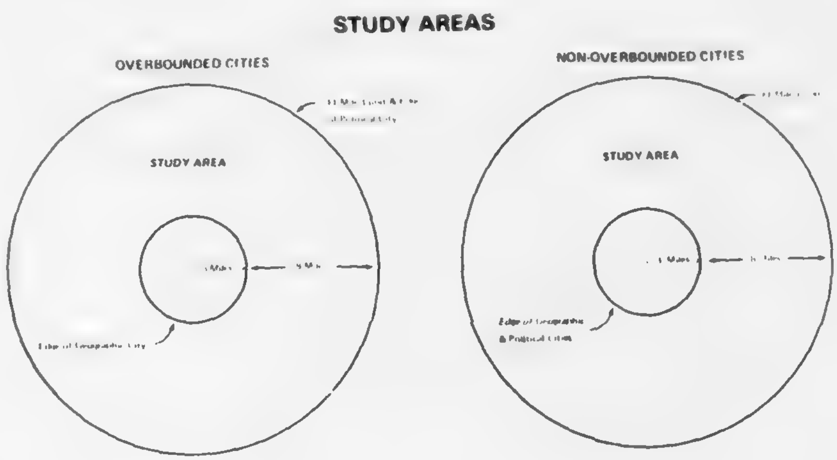

Figure 2. Sample Study Areas

I base my hypothesis on the assumption that residential land developers always attempt to maximize profit. Political boundaries are significant to this behavior because they can influence the cost of the development process. The cost of providing services is higher to the developer, and subsequently to the home purchaser, outside the city's political boundaries. The increased cost to the

homeowner results from a dual set of expenses. First, the residential land developer operating beyond the urban political limits must absorb the cost of utility extensions, a cost which is subsequently passed to the consumer. Additionally, the homeowner who lives beyond the political boundary pays proportionately larger rates for the continuous use of utilities. This homeowner also pays a higher annual insurance rate because insurance companies consider volunteer fire departments less effective.

I interviewed Texas developers who indicated that they considered the decision-making process of the potential homeowner in the selection of a site for residential development. Scholars who have analyzed this decision-making process conclude that economic considerations weigh heavily in selecting a location. The potential home buyer is not only concerned with accessibility and the ethnic and social characteristics of a neighborhood, but also considers home price, transportation costs, public utility services, and availability of fire and police protection.[7]

If the above assumptions are valid, density of dwellings per square mile ought to be dissimilar for overbounded and non-

---

[7] Lawrence A. Brown and Eric G. Moore, "The Intra-Urban Migration Process: A Perspective," Geografiska Annaler, Ser. G., Vol. 52 (1970), pp. 1-13; Peter H. Rossi, Why Families Move: A Study in the Social Psychology of Urban Residential Mobility (New York: The Free Press, 1955); James W. Simmons, "Changing Residence in the City: A Review of Intraurban Mobility," Geographical Review, Vol. 58 (1968), pp. 622-651.

overbounded city samples located equidistant from the periphery of the geographic city. These data represent the end result of the above described decision making process, and will reflect growth in areas where the home purchaser is content with social and economic considerations.

THE CONCEPTUAL MODEL

Several social scientists used the exponential distance decay function to approximate the distribution of urban population around the city core.[8] Because population and dwelling unit density interrelate, it is possible to substitute the latter variable in the function without altering the theoretical association. I postulate that this function also describes the residential growth of population beyond the built-up city in cases where the political boundary is coincident with the geographic city. Several sources indicate this to be the case, noting that while more affluent families tend to move beyond the edge of the geographic city, the majority of movers advance only a short distance farther from the city center on each move.[9]

---

[8] Colin Clark, "Urban Population Densities," Journal of the Royal Statistical Society, Series A, Vol. 114 (Part IV, 1951), pp. 490-496; Richard F. Muth, "The Spatial Structure of the Housing Market," Papers and Proceedings of the Regional Science Association, Vol. 7 (1961), pp. 207-220; Bruce F. Newling, "Urban Growth and Spatial Structure: Mathematical Models and Empirical Evidence," Geographical Review, Vol. 56 (1966), pp. 213-225.

[9] Janet Abu-Lughod and Mary Mix Foley, "The Consumer Votes by Moving," in William L.C. Wheaton, Grace Milgram, and Margy Ellin Meyerson, eds. Urban Housing (New York: The Free Press, 1966); Brown and Moore, op.cit.; Simmons, op. cit.

If developers considered only land costs, then parcels of land located farthest from the geographic city would be most lucrative for development. Accessibility, however, is a major factor in the developability of a land parcel, and most residential growth predictably occurs adjacent to the geographic city in both city categories.

This author contends that accessibility of a parcel of land decreases to some point beyond the geographic city, but levels off after reaching a threshold value. Nearly everyone considers a location one mile distant from the geographic city more accessible than a location two miles distant. The person, however, who can afford the temporal and monetary accessibility cost of a distant home probably would not consider a home located seven miles from the geographic city to be more inaccessible than one located six miles distant. Wolforth supported this contention, showing that London workers commute from as far away as fifty miles, indicating they do not consider their landholdings significantly more inaccessible than those closer in.[10]

If the developer can provide incentives that offset commuting costs for potential homeowners of the lower and middle socio-economic classes, he will probably alter demand, and draw additional home

---

[10] John Wolforth, "The Journey to Work," in Larry S. Bourne, ed., Internal Structure of the City (New York: Oxford University Press, 1971).

purchasers to distant locations. Beyond the moderating point in the increase of accessibility cost, a decrease in land cost combined with other necessary incentives will attract these homeowners.

Development Costs

No generally accepted land cost curve applies only to areas beyond the city's built-up portion. Developers in the study area provided necessary data for constructing such a curve. These developers were unanimous in their opinion that land cost was highest near the edge of the geographic city where land holders were speculating that development would soon encompass their land parcel. They noted a sharp drop in this cost a few miles beyond the built-up area of the city where a lesser degree of speculation was occurring, and relatively cheap land farther out that was used almost exclusively for agriculture.

The formal curve most closely approximating these developer relationships is an inverted logistic type (Fig. 3). Specifically, the curve is of the form:

$$LC_d = U - \frac{U}{1 + e^{a-bd}} \quad (1)$$

Where:

LC_d = land cost at distance d from the edge of the geographic city

U = upper limit equilibrium point

d = distance from the edge of the geographic city

b = model parameter

a = model parameter

e = log constant

This land cost curve for fringe areas reflects market demand for accessible land and applies to both the overbounded and non-overbounded city study areas.

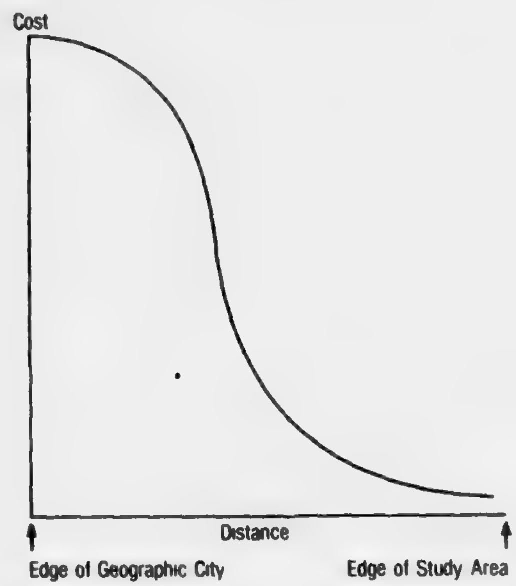

Figure 3. Land Costs

If a developer absorbs development costs for services such as water and sewage, he passes them to the consumer.[11] Because

[11]Reginald Golledge, "Sydney's Metropolitan Fringe: A Study in Urban-Rural Relations," Australian Geographer, Vol. 7 (1959), pp. 243-255; Robert O. Harvey and W.A.V. Clark, "The Nature and Economics of Urban Sprawl," Land Economics, Vol. 41 (1965), pp. 1-9.

service costs vary, assessments differ for identical houses at separate locations. Developers noted significant differences in service costs depending upon the location of the land parcel relative to the political boundary. Beyond the corporation boundary there is usually a lack of city water and sewage services, curbs, sidewalks, and paved streets. Although utility services enhance the desirability of land, interviews with public works officials by this researcher revealed that none of the eleven cities containing the study areas provided city installed water and sewage services outside their political boundaries.[12] Fringe residents often have to rely on rural governments to provide these services, and these rural towns and counties commonly do not possess the necessary legal powers to do so.[13]

The postulated service costs generate two curves, one for each city category. In non-overbounded city samples the developer absorbs expenses and passes these directly to the home purchaser, with no financial aid from the municipal government. As the cost of extending sewage and water services increases in direct proportion to distance, the developer pays a linear cost when extending these services to unserviced areas. Conversely, developers operating

---

[12]Julius Margolis, "The Demand for Urban Public Services," in Harvey S. Perloff and Lowdon Wingo, Jr., eds., Issues in Urban Economics (Baltimore: The Johns Hopkins Press, 1968).

[13]Blizzard, op. cit.; George S. Wehrwein, "The Rural-Urban Fringe," Economic Geography, Vol. 18 (1942), pp. 217-228.

in overbounded city samples pay a standard service entry fee, which is the same for all areas within the political boundary. Here the municipal government largely absorbs the cost of connection to city utility services (Figs. 4 and 5).

Specifically, these service cost curves are of the form:

(2) $SC_d = a + (cb)d$

where:

SC_d = services cost at distance d from the edge of the geographic city

a = service entry fee

c = 0 if the curve is for overbounded city samples

c = 1 if the curve is for non-overbounded city samples

b = slope - the cost gradient - the cost increase for each additional distance unit extension of services

d = distance

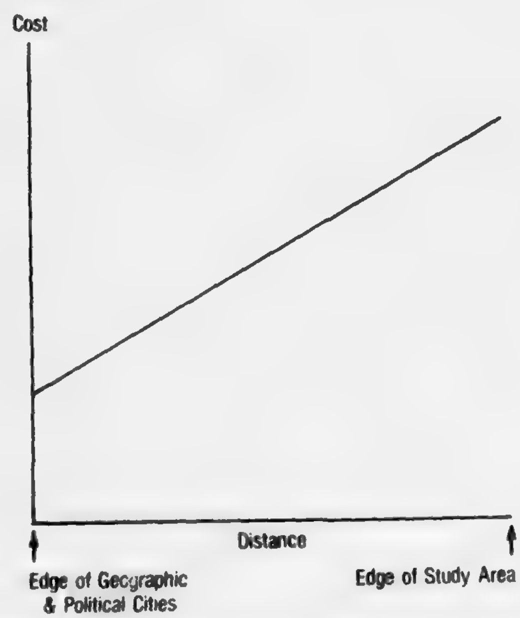

Figure 4. Service Costs, Non-Overbounded Cities

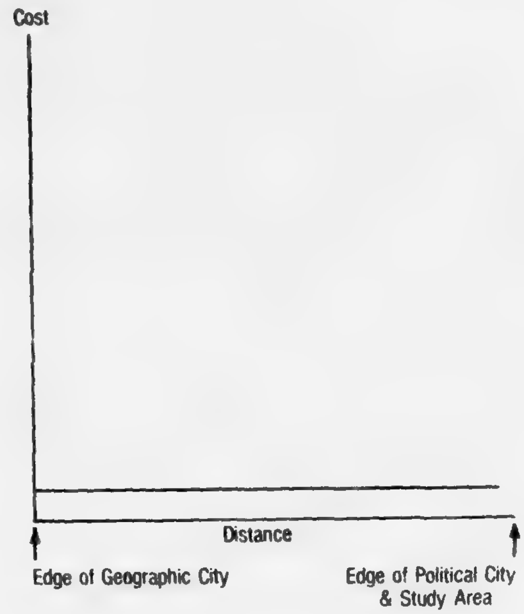

Figure 5. Service Costs, Overbounded Cities

In addition to developer utility service costs, I noted that none of the eleven cities provided services such as fire and police protection beyond their city limits. While the absence of these services may not appear to represent a cost to the home purchaser, it actually does. Fire and theft insurance rates, for example, reflect the comparative availability of protection inside and outside a city's political limits, and were consistently higher beyond the political borders of the eleven sampled cities.

Total development cost curves reflect a combination of land and service costs at each point throughout the distance spectrum of the study areas. Two different total cost curves can be postu-

lated because of different service costs. Since service costs for overbounded city samples consist only of the constant entry fee, adding this relatively low cost to the land cost curve does not alter the structure but merely the position of that curve. Therefore, the total development cost curve for overbounded city samples is similar in form to the land cost curve previously postulated in Figure three (Fig. 6).

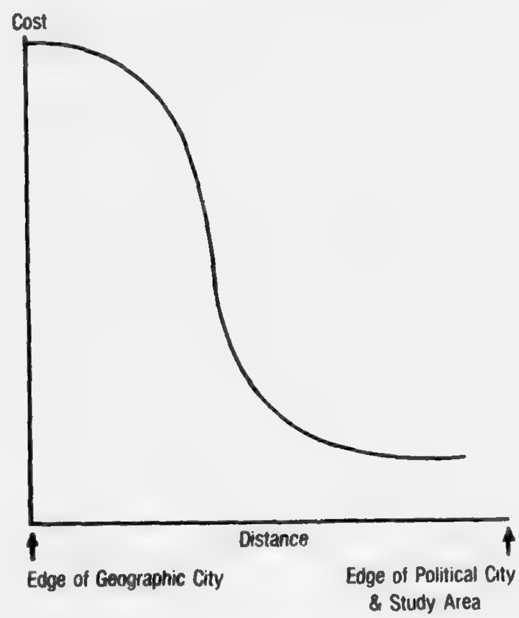

Figure 6. Total Development Costs, Overbounded Cities

The total development cost curve for non-overbounded city samples consists of meshing service and land costs throughout the distance spectrum. Because the service cost increases linearily with distance in these samples, both the position and the

form of this total cost curve are markedly different from the land cost curve postulated in Figure three (Fig. 7).

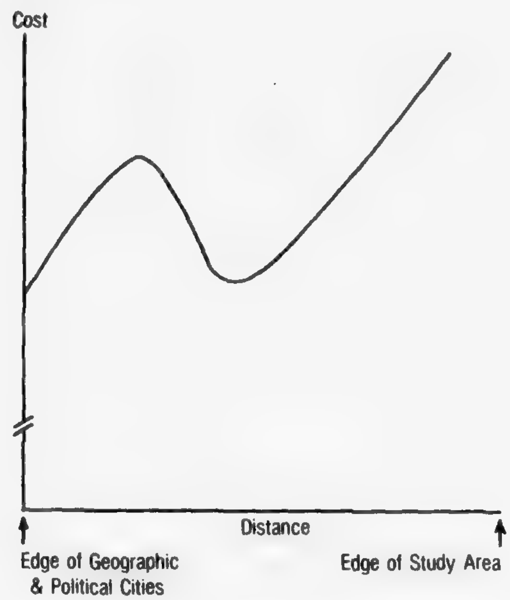

Figure 7. Total Development Costs, Non-Overbounded Cities

Postulated Residential Development Curves

Residential development in rural areas adjacent to geographic cities is postulated to have occurred in two different forms, given the demand and cost functions presented above, depending on whether the samples exist in overbounded or non-overbounded cities. A combination of demand to live in the most accessible areas and increasing development cost with distance indicates that when geographic and political boundaries of a city coincide, residential growth beyond the geographic city adheres

closely to an exponential distance decay function (Fig. 8) of the form:

(3) $Y = ae^{-bx}$

where:

Y = residential density at distance x from the edge of the geographic city

a = model parameter

e = base of natural logarithms

b = model parameter

x = distance

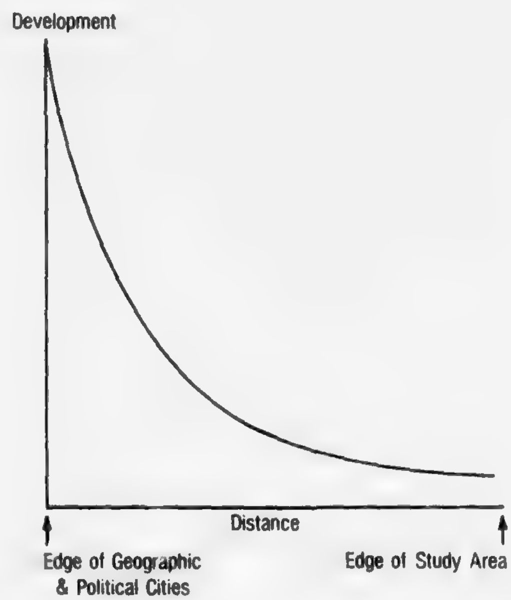

Figure 8. Postulated Residential Development, Non-Overbounded Cities

Cost follows a continual decline with distance in overbounded city samples in contrast with the generally increasing development

cost with distance for the non-overbounded city study area. Recall that there is a point beyond the geographic city where the decrease in perceived user accessibility is moderated. Beyond this point proportionately more families in the overbounded than in the non-overbounded study area are able to achieve satisfaction in a distant fringe residence.

The postulated residential development curve for the overbounded city approximates an exponential distance decay function to a point beyond the geographic city because developers perceive that most potential homeowners desire to live in the most accessible locations. But unlike the curve for a non-overbounded city, this curve has an additional quadratic function at the outer reaches of the distance spectrum because of the relatively low development costs in the periphery of the study area (Fig. 9).

Formally, this curve represents the equation:

(4) $Y = a + b_1X + b_2X^2 + b_3X^3 + e$

where:

Y = residential density at distance X from the edge of the geographic city

a = model parameter

b = model parameter

X = distance

Figure 9. Postulated Residential Development, Overbounded Cities

Others who have analyzed growth in a variety of cities where the settlement of discontinuous land plots was common support the possibility of the existence of a curve such as this. Residential density waves out from the city center have been shown to rise relatively steeply to a peak, decline and flatten out, and rise again.[14]

FINDINGS

I selected rural mile square samples for each city type (overbounded and non-overbounded) in a stratified random process by

[14] Hans Blumenfeld, "The Tidal Wave of Metropolitan Expansion," Journal of the American Institute of Planners, Vol. 20 (1954), pp. 3-14; Boyce, op. cit.

mileage band beyond the geographic cities, and anlyzed dwelling density data in statistical tests to determine their fit with the conceptual model.

Traditional definitions of overboundedness are based on the degree to which political boundaries extend beyond the city's built-up area. Despite basic agreement with the concept, no standard extension distance exists. Rather than a distance criterion, I classified cities in this study as overbounded or non-overbounded based on the percentage of rural land in any one city when compared to a similar percentage for each of the other cities under study.

A single linkage clustering algorithm classified the cities into the two groups based on the percentage of rural land in 1963 within each city's political limit. I then grouped these percentages, which ranged from zero to thirty-three, by distance to nearest neighbor. Each category (overbounded and non-overbounded) contained cities of varying sizes with different growth rates. The average growth rates for the two groups, however, are statistically similar.

TABLE 1

CHANGES IN SAMPLE CITY POPULATIONS, 1960-1970

Overbounded Cities				Non-Overbounded Cities			
City	1960 Pop	1970 Pop in 1960 Area	% Change	City	1960 Pop	1970 Pop in 1960 Area	% Change
Amarillo....	137,969	123,735	-11.4	Austin....	186,545	207,159	11.0
Beaumont....	119.175	117,548	- .1	Houston...	938,219	1,197,278	27.6
Corpus Christi....	167,690	179,218	6.8	San Antonio..	587,718	639,687	8.8
Dallas......	679,684	833,065	22.5	Wichita Falls....	101,724	95,901	-6.0
El Paso.....	276,687	321,945	16.3				
Ft. Worth...	356,268	382,431	7.3				
Lubbock.....	128,691	149,101	15.9	Mean Percentage Change = 10.35			
Mean Percentage Change = 8.19				Standard Deviation = 11.91			
Standard Deviation = 10.59				t = -.2816325			

Source: 1970 U.S. Census of Population, Number of Inhabitants, Texas. Statistical Test Calculated by Author (See Appendix)

To have a baseline from which to measure change, it was necessary that the mile square samples for each city were in rural land use in 1963. I used ten-year old aerial photography and topographic maps of each of the cities were used to identify parcels that were rural in 1963.

For non-overbounded cities these samples were located between the political and geographic city and a selected eleven mile limit. For overbounded cities the samples were located between the geographic

city and a similar eleven mile limit that coincided with the political city (Fig. 2).

I used the eleven mile limit because it was the average radius of the political limits of Houston, the largest city, in 1973. Since neither the geographic nor the political cities of the other urban areas under study exceeded this eleven mile limit, this radius was the maximum extent for each study area. No rural samples were closer to the city center than three miles in either category; therefore, the study area for each city category was eight miles wide.

In each of the eight mileage bands, the mean for the density of dwellings was greater in the overbounded city samples. Statistically significant differences in density, however, were not so frequent, since the mean density was greater (at the .05 alpha level) for overbounded city samples only in the fifth and sixth mileage bands.

TABLE 2

DENSITY DIFFERENCES BETWEEN CITY CATEGORIES

BY MILEAGE BANDS

Mile	City Category	n	$\bar{x}$	log $\bar{x}$	Std. Dev.	Cal. t	Table t
1	Overbounded........	21	213	1.88667	.70341	.92416	1.684
	Non-Overbounded....	21	126	1.69009	.64049		
2	Overbounded........	15	94	1.60960	.58173	1.47228	1.701
	Non-Overbounded....	15	82	1.30627	.50584		
3	Overbounded........	18	107	1.68846	.59123	.74943	1.697
	Non-Overbounded....	18	63	1.49460	.46828		
4	Overbounded........	12	56	1.56539	.45674	.64959	1.717
	Non-Overbounded....	12	34	1.44568	.40613		
5	Overbounded........	4	104	1.72860	.50448	1.98297	1.943
	Non-Overbounded....	4	3	1.11018	.09854		
6	Overbounded........	5	143	2.01819	.34462	2.39450	1.860
	Non-Overbounded....	5	10	1.39093	.39461		
7	Overbounded........	8	23	1.33731	.37806	1.66881	1.761
	Non-Overbounded....	8	2	1.07295	.33853		
8	Overbounded........	2	3	1.11266	.03447	1.36245	2.920
	Non-Overbounded....	2	2	1.06029	.01889		

Source: Calculated by author (see Appendix)

This research report is concerned with the process (slope) as well as the form (density) of development. I analyzed the data for dwelling density in a least squares procedure where the dependent variable was density and the independent variable distance. I viewed density as a function of distance, and slope parameters served as indicators of the residential growth process.

If development in overbounded and non-overbounded city samples was as postulated previously, the data for overbounded cities would best be fit by a polynomial least squares model of the third degree, whereas that for the non-overbounded cities would not. A fourth degree polynomial model was fitted to the dwelling density data for both city categories, determining the relative goodnesses of fit from F-ratios of variation based on regression divided by deviation about regression.

For overbounded cities the F score was highest with a linear model, but, beyond that, the scores increased to the third degree, and began to descend with the quartic model. For non-overbounded cities the F scores declined as expected, with each increase in the degree of the exponent (Figs. 10 and 11).

TABLE 3

F-RATIOS FOR POLYNOMIAL REGRESSION

ALL SAMPLES

City Category	Degree of Polynomial	F-Ratio
Overbounded	1st	3.87671
	2nd	1.95533
	3rd	2.40722
	4th	1.85273
Non-Overbounded	1st	24.32436
	2nd	12.14429
	3rd	8.08558
	4th	6.54442

Source: Calculated by author

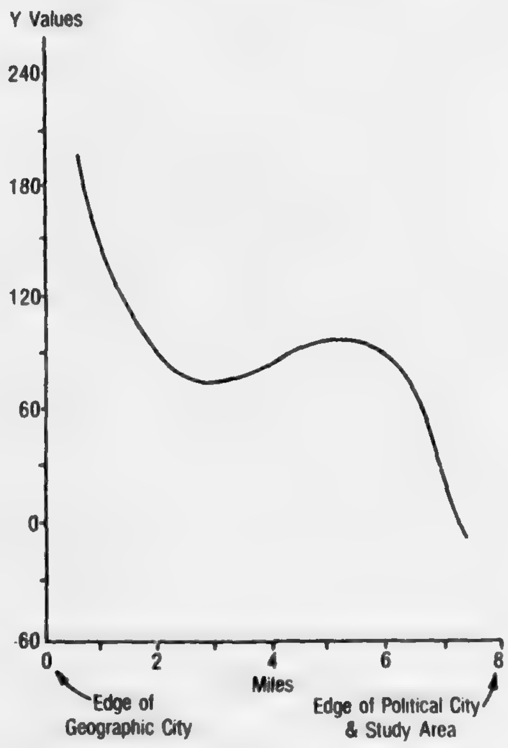

Figure 10. Predicted Y Values, Cubic Polynomial Regression Model, Mean Data by Mileage Band, Overbounded Cities

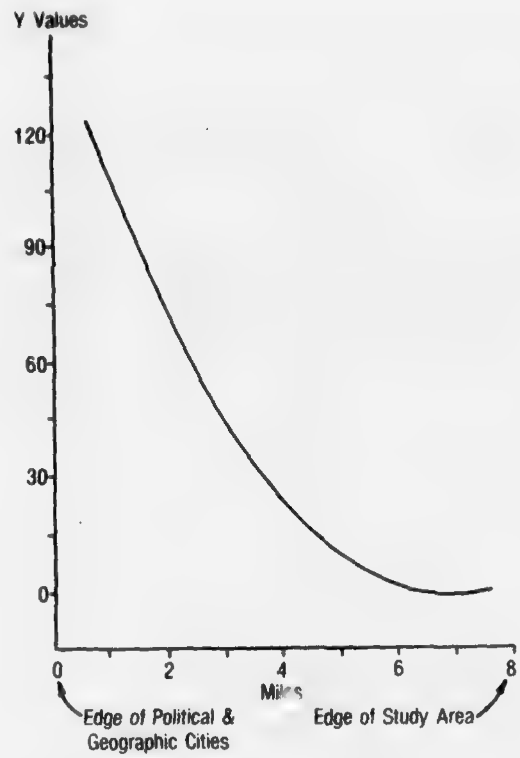

Figure 11. Predicted Y Values, Cubic Polynomial Regression Model, Mean Data by Mileage Band, Non-Overbounded Cities

SUMMARY AND PROSPECTS

An analysis of density of dwellings by mileage bands revealed statistically significant differences only near the outer limits of the distance spectrum. The process of growth is as important as the form, and it too adheres to the postulated residential development curves presented earlier.

Residential development within an urban context is a complex process. Decisions as to when and where to develop center in the hands of a few. Correct decisions are essential to this group to maintain their market position. Consequently, developers are sensitive to a number of development factors. In its simplest

form, I view these factors as cost and market variables. This simple framework, however, obfuscates the myriad of variables to be analyzed before making development decisions. Topography, accessibility, neighborhood quality, landscape aesthetics, and service costs are only a handful of the important factors. Federal policy, land environment, business cycles, and political climate influence these variables.

From this myriad of variables I selected one factor, limits of political jurisdiction, and attempted to determine whether it influences the spatial pattern of residential development. Geographers and others have often ignored the significance of political boundaries in metropolitan studies in favor of "functional" boundaries. Yet, political boundaries can and do represent meaningful limits for certain activities or perceptions. The premise of this study is that political boundaries are meaningful to the residential development process because they influence the cost of development through service cost. The nexus is thus: political limits ⟶ service costs ⟶ development patterns. Based on these results, judicious approval of annexations can be used as a planning tool in regulating the future direction and rate of urban residential growth.

BIBLIOGRAPHY

Journal Articles

Alonso, William. "A Theory of the Urban Land Market." Papers and Proceedings of the Regional Science Association, 6 (1960), 149-158.

Beegle, J. Allan. "Characteristics of Michigan's Fringe Population." Rural Sociology, 12 (1947), 254-263.

Blizzard, Samuel W. "Research on the Rural-Urban Fringe." Sociology and Social Research, 38 (1954), 143-149.

Blumenfeld, Hans. "The Tidal Wave of Metropolitan Expansion." Journal of the American Institute of Planners, (1954), 3-14.

Boyce, Ronald R. "The Edge of the Metropolis: The Wave Theory Analog Approach." British Columbia Geographical Series, 7 (1966), 31-40.

Bromley, David G. and Smith, Joel. "The Historical Significance of Annexation as a Social Process." Land Economics, 49 (1973), 294-309.

Brown, Lawrence A. and Moore, Eric G. "The Intra-Urban Migration Process: A Perspective." Geografiska Annaler, Series G, 52 (1970), 1-13.

Chapin, F. Stuart, Jr., Donnelly, Thomas G., and Weiss, Shirley F. "A Model for Simulating Residential Development." Journal of the American Institute of Planners, 21 (1965), 120-125.

Clark, Colin. "Urban Population Densities." Journal of the Royal Statistical Society, Series A, 114, Part IV, (1951), 490-496.

Downs, Anthony. "Alternative Forms of Future Urban Growth in the U.S." Journal of the American Institute of Planners, 36 (1970), 3-11.

Golledge, Reginald. "Sydney's Metropolitan Fringe: A Study in Urban Rural Relations." Australian Geographer, 7 (1959), 243-255.

Harvey, Robert O. and Clark, W.A.V. "The Nature and Economics of Urban Sprawl." Land Economics, 41 (1965), 1-9.

Johnston, R.J. "The Population Characteristics of the Urban Fringe; A Review and Example." Australian and New Zealand Journal of Sociology, 2 (1966), 70-93.

Muth, Richard F. "Economic Change and Rural-Urban Land Use Conversions." Econometrica, 29 (1961), 1-24.

Muth, Richard F. "The Spatial Structure of the Housing Market." Papers and Proceedings of the Regional Science Association, 7 (1961a), 207-220.

Newling, Bruce F. "Urban Growth and Spatial Structure: Mathematical Models and Empirical Evidence." Geographical Review, 56 (1966), 213-225.

Newling, Bruce F. "The Spatial Variation of Urban Population Densities." Geographical Review, 59 (1969), 242-252.

Simmons, James W. "Changing Residence in the City: A Review of Intraurban Mobility." Geographical Review, 58 (1968), 622-651.

Wehrwein, George S. "The Rural-Urban Fringe." Economic Geography, 18 (1942), 217-228.

Books

Abu-Lughod, Janet and Foley, Mary Mix. "The Consumer Votes by Moving." In Urban Housing. Edited by William L.C. Wheaton, Grace Milgram, and Margy Ellin Meyerson. New York, N.Y.: The Free Press, 1966.

Alonso, William. Location and Land Use, Toward A General Theory of Land Rent. Cambridge, Mass.: Harvard University Press, 1964.

Margolis, Julius. "The Demand for Urban Public Services." In Issues in Urban Economics. Edited by Harvey S. Perloff and Lowdon Wingo, Jr. Baltimore, Md.: The Johns Hopkins Press, 1968.

Murphy, R.E. The American City, An Urban Geography. New York, N.Y.: McGraw-Hill, 1966.

Rossi, Peter H. Why Families Move: A Study in the Social Psychology of Urban Residential Mobility. New York, N.Y.: The Free Press, 1955.

Wolforth, John. "The Journey to Work." In Internal Structure of the City. Edited by Larry S. Bourne. New York, N.Y.: Oxford University Press, 1971.

Published Reports

Chapin, F. Stuart, Jr. and Weiss, Shirley F. Factors Influencing Land Development. Chapel Hill, N.C.: University of North Carolina Press, 1962.

Donnelly, Thomas G., Chapin, F. Stuart, Jr., and Weiss, Shirley F. A Probabilistic Model for Residential Growth. Chapel Hill, N.C.: University of North Carolina Press, 1964.

Government Documents

U.S. Census of Population, Number of Inhabitants, Texas, 1970. Washington, D.C.: U.S. Government Printing Office, 1973.

APPENDIX

Statistical Calculations

Percentage Change in City Population 1960 - 1970, in 1960 Area

$$t = \frac{\bar{x}_1 - \bar{x}_2 - d}{S_o \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

where:

$$S_o^2 = \frac{\Sigma(x_{1i} - \bar{x}_1)^2 + \Sigma(x_{2i} - \bar{x}_2)^2}{n_1 + n_2 - 2}$$

$$S_o^2 = \frac{785.208540 + 567.710000}{9}$$

$$S_o = 12.260679$$

$$t = \frac{8.1857142 - 10.3500000}{12.260679 \sqrt{\left(\frac{1}{7} + \frac{1}{4}\right)}} \qquad (5)$$

$$t = -.2816325$$

Table t value = 2.262

Density Differences Between City Categories by Mileage Bands - Density of Dwellings

1st Mileage Band

$$t = \frac{\bar{x}_1 - \bar{x}_2 - d}{S_o \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

where:

$$S_o^2 = \frac{\Sigma(x_{1i} - \bar{x}_1)^2 + \Sigma(x_{2i} - \bar{x}_2)^2}{n_1 + n_2 - 2}$$

$$S_o^2 = \frac{10.390555 + 8.6146494}{40}$$

$$S_o = .6892968$$

$$t = \frac{1.8866728 - 1.6900852}{.6892968\sqrt{\left(\frac{1}{21} + \frac{1}{21}\right)}} \tag{6}$$

$$t = .9241552$$

2nd Mileage Band

$$S_o^2 = \frac{5.076104 + 3.8380427}{28}$$

$$S_o = .564236$$

$$t = \frac{1.6095993 - 1.3062666}{.564236\sqrt{\left(\frac{1}{15} + \frac{1}{15}\right)}} \tag{7}$$

$$t = 1.4722765$$

3rd Mileage Band

$$S_o^2 = \frac{6.2919768 + 3.9472221}{34}$$

$$S_o = .5487739$$

$$t = \frac{1.6884677 - 1.4945955}{.5487739\sqrt{\left(\frac{1}{18} + \frac{1}{18}\right)}} \tag{8}$$

$$t = .7494258$$

4th Mileage Band

$$S_o^2 = \frac{2.5033442 + 1.9792892}{22}$$

$$S_o = .4513933$$

$$t = \frac{1.5653866 - 1.44568}{.4513933 \sqrt{\left(\frac{1}{12} + \frac{1}{12}\right)}} \tag{9}$$

$$t = .649589$$

5th Mileage Band

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{Q}{n^2_1(n_1-1)}}}$$

where:

$$\bar{x}_1 = \frac{1}{n_1} \Sigma x_{1i}$$

$$\bar{x}_2 = \frac{1}{n_2} \Sigma x_{2i}$$

$$u_i = x_{1i} - x_{2i} \sqrt{\frac{n_1}{n_2}} \qquad (i - 1, 2 \ldots, n_1)$$

$$\bar{u} = \frac{1}{n_1} \Sigma u_i$$

$$Q = n_1 \Sigma (u_i - \bar{u})^2 = n_1 \Sigma u_,^2 - (\Sigma u_i)^2$$

$$u_i = 2.47368$$

$$u_i^2 = 2.69690$$

$$Q = 4\ (2.69690) - (2.47368)^2$$

$$Q = 4.668508$$

$$t = \frac{1.7285975 - 1.1101775}{\sqrt{\frac{4.668508}{48}}} \qquad (10)$$

$$t = 1.9829664$$

6th Mileage Band

$$S_o^2 = \frac{.593829 + .7785922}{8}$$

$$S_o = .414189$$

$$t = \frac{2.018188 - 1.390934}{.414189 \sqrt{\frac{1}{5} + \frac{1}{5}}} \qquad (11)$$

$$t = 2.3945004$$

7th Mileage Band

$$Q = 8\ (1.96447) - (2.11493)^2$$

$$Q = 11.242832$$

$$t = \frac{1.3373112 - 1.072945}{\sqrt{\frac{11.242832}{448}}} \qquad (12)$$

$$t = 1.668811$$

8th Mileage Band

$$S_o^2 = \frac{.002241 + .000714}{2}$$

$$S_o = .0384382$$

$$t = \frac{1.112655 - 1.060285}{.0384382 \sqrt{\frac{1}{2} + \frac{1}{2}}} \qquad (13)$$

$$t = 1.3624467$$

GLOSSARY OF TERMS

Built-up Area of a City - As used here, it is synonomous with Murphy's definition of the "Geographic City," where

> "the built-up area (extends) in all directions until significantly interrupted by farms, forest, or other non-urban land, or by water bodies" (R.E. Murphy, The American City, An Urban Geography. New York: McGraw-Hill, 1966, p. 13).

As an operational definition for this research work, the geographic city is defined as that portion of a political city in which the square mile sections of land contain less than fifty percent rural land use.

City Center - The original city center as identified from maps and aerial photography. The original courthouse or post office is situated on this block. It is not necessarily the geometric city center.

Geographic City - "the built-up area extending in all directions until significantly interrupted by farms, forest, or other non-urban land, or by water bodies" (Murphy, 1966, p. 13). As an operational definition for this research work, the geographic city is defined as that portion of a political city in which the square mile sections of land contain less than fifty percent rural land use.

Overbounded and Non-Overbounded Cities - For the purpose of this study, all surveyed cities fall into one of these two dichotomous classes. Cities are classified into natural categories with a linkage analysis, with any city classified as overbounded or non-

overbounded based on the percentage of rural land in that city when compared to the percentage of this type land within the borders of each city studied.

Political City - The legal area of the city as encompassed by its political boundary (city limits).

Rural Land - Land in agricultural use, idle land, and land in forest. Excluded is land permanently covered by water and U.S. Government property. An area is classified as rural or non-rural based on the observable land use and not necessarily its functional classification.

Rural-Urban Fringe - That portion of land on the periphery of a geographic city where the settlement pattern is discontinuous. Wehrwein described it as an area in transition between well recognized urban land uses and the area devoted to agriculture (1942).

Urban Sprawl - Discontinuous urban development that occurs on the periphery of many cities. Developed land may be located more distant from the geographic city than are other plots that have experienced no residential growth.